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The purpose of this study was to evaluate the effects of sentry duty time on the soldier's speed of detection of visually presented targets, his ability to hit targets (rifle marksmanship), and his mood. Prior to the test day, each of eight subjects was given five days of training on the Weaponeer Rifle Marksmanship Simulator and was familiarized with the targets to be presented during testing. The test session lasted three hours, during which time the subject assumed a standing foxhole position and monitored the target scene of the Weaponeer. The Weaponeer M16A1 modified rifle lay next to the subject at chest height. When a pop-up target appeared, the subject pressed a telegraph key, lifted the rifle, aimed, and fired at the target. Speed of target detection was measured in terms of the time required by the subject to press the telegraph key in response to the presentation of the target. Marksmanship was measured in terms of number of targets hit. Target detection time and rifle marksmanship were averaged every 30 minutes. At the end of the test session, the subject completed the Profile of Mood States rating scale.

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19. Abstract (Continued)

The results showed that target detection time deteriorated with time on sentry duty; impairments were not evident within the first hour but were clearly evident by 1.5 hours. Marksmanship remained constant over time; soldiers were just as accurate in hitting the targets at the end of the 3 hours of sentry duty as they were at the beginning. Whereas the soldier's predominant mood during baseline practice sessions was one of vigor, during sentry duty the predominant mood was one of fatigue. The results of this study suggest that sentry duty performance may be optimized if it is limited to one hour or less.

TARGET DETECTION, RIFLE MARKSMANSHIP, AND MOOD DURING THREE HOURS OF SIMULATED SENTRY DUTY

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ABSTRACT

The purpose of this study was to evaluate the effects of sentry duty time on the soldier's speed of detection of visually presented targets, his ability to hit targets (rifle marksmanship), and his mood. Prior to the test day, each of eight subjects was given five days of training on the Weaponeer Rifle Marksmanship Simulator and was familiarized with the targets to be presented during testing. The test session lasted three hours, during which time the subject assumed a standing foxhole position and monitored the target scene of the Weaponeer. The Weaponeer M16A1 modified rifle lay next to the subject at chest height. When a pop-up target appeared, the subject pressed a telegraph key, lifted the rifle, aimed, and fired at the target. Speed of target detection was measured in terms of the time required by the subject to press the telegraph key in response to the presentation of the target. Marksmanship was measured in terms of number of targets hit. Target detection time and rifle marksmanship were averaged every 30 minutes. At the end of the test session, the subject completed the Profile of Mood States rating scale. The results showed that target detection time deteriorated with time on sentry duty; impairments were not evident within the first hour but were clearly evident by 1.5 hours. Marksmanship remained constant over time; soldiers were just as accurate in hitting the targets at the end of the 3 hours of sentry duty as they were at the beginning. Whereas the soldier's predominant mood during baseline practice sessions was one of vigor, during sentry duty the predominant mood was one of fatigue. The results of this study suggest that sentry duty performance may be optimized if it is limited to one hour or less.

INTRODUCTION

In Mackworth's classic work on vigilance (Mackworth, 1950), it was shown that the ability to detect infrequent and brief (less than 1.0 second) stimulus changes in the visual field deteriorated after only one-half hour of sustained attention and remained deteriorated for the remainder of a two hour test session. Mackworth went on to show that subjects become tired during periods of sustained attention, and that they perform better if they alternate one-half hour of vigilance testing with one-half hour of rest. While Mackworth's task was modelled after that of a sonar operator, the task is also analogous to that of a soldier on sentry duty who must scan a visual field and detect the appearance of enemy targets. Unlike Mackworth's task, however, the soldier on sentry duty must not only detect the sudden appearance of a visual target but the soldier must also pick up a rifle, aim, and fire accurately at the target.

In recent years, the US Army has introduced a rifle simulator into its basic rifle marksmanship training. This simulator, called the Weaponeer (Spartanics, Inc.), utilizes a modified M16A1 rifle and incorporates realistic recoil and realistic auditory feedback. The Weaponeer was designed to facilitate the diagnosis of soldiers' shooting problems, the remedial training of poor shooters, and the enhancement of the teaching and practicing of rifle marksmanship fundamentals (Spartanics, 1985). After preliminary training on the Weaponeer, the soldier completes his marksmanship training with live fire on a standard rifle range. Soldier performance on the Weaponeer has been shown to be predictive of actual live fire performance on the rifle range (Schendel, 1985).

With the development of the Weaponeer, it is now possible to conduct empirical investigations of sentry duty performance

under controlled laboratory conditions (Johnson and Kobrick, 1988; Kobrick, Johnson, and McMenemy, 1988). The purpose of this study was to evaluate the effects of sentry duty time on the soldier's speed of detection of visually presented targets, his ability to hit the targets (rifle marksmanship), and his mood (including subjective fatigue).

METHOD

Eight male soldier volunteers, ages 18-42, were recruited from the military volunteer test subject population at the US Army Natick Research, Development and Engineering Center (Natick, MA). All were familiar with the Weaponeer having utilized it during basic training. Only those prospective test subjects with normal correctable vision (20/20 Snellen) were allowed to participate. During all practice and test sessions, subjects were dressed in the standard US Army battle dress uniform (including helmet, web belt, and full canteen).

Practice sessions. On each of five days during the week prior to testing, each subject was given practice on the Weaponeer and was familiarized with the pop-up targets to be presented during the subsequent test session (full body E-type silhouettes at a simulated distance of 250 meters). On each practice day, each subject assumed a standing foxhole position (with the rifle supported by sandbags) and repeatedly fired a non-paced series of 9 shots at a scaled 25 meter zeroing target (black E-type silhouette) until he had a tight shot group (8 of 9 shots falling within a 3/8 inch x 3/8 inch square (a 2 x 2 Weaponeer grid square)). Once the subject attained a tight shot group, he then received practice firing at randomly presented pop-up targets (E-type silhouettes) at simulated distances of 100 and 250 meters. Each 100 meter target was set to appear for 3 seconds, while each 250 meter target was set to appear for 6 seconds. The time interval between the disappearance of one target and the appearance of the next one was 1 second. Thirty-two pop-up targets were presented twice (once while the subject fired with the rifle supported by sandbags and once while the subject fired with the rifle unsupported) for a total of 64 pop-up targets. After the 64 pop-up target presentations, the subject was administered 12 random presentations of the target to be used during the test sessions (Weaponeer target #2, the 250 meter green E-type silhouette) with the time interval between presentations varying from 15 to 60 seconds. The administration of (a) the zeroing exercise, (b) the 64 pop-up targets, and (c) the 12 test-target presentations constituted one training cycle. Each subject was administered two training cycles on each of the five practice days for a total of ten training cycles. At the end of training, all subjects were able to achieve a tight shot group on the zeroing target, and the average number of hits per 32 pop-up target presentations was 27.3 (supported) and 24.8 (unsupported). At the end of each practice day, the subject was administered the Profile of Mood States (POMS) rating scale (McNair, Lorr, and Droppelman, 1981). The POMS measures 6 moods: tension, depression, anger, vigor, fatigue, and confusion.

Test session. Testing was conducted in the morning between 0800 and 1200 hours. Subjects were not permitted to consume alcohol during the 24 hours prior to a test day, and were instructed to be in bed by 2200 hours the night before a test day. The test session lasted three hours, during which time the subject assumed a standing foxhole position (supported) and monitored the target scene of the Weaponeer. He was told to monitor the target scene and to fire at a target when it appeared. The Weaponeer M16A1 modified rifle lay next to the subject at chest height. When a pop-up target appeared, the subject pressed a telegraph key, lifted the rifle, aimed, and fired at the target. The number of stimulus (target) presentations per 30 minute period was 12, with interstimulus intervals of .75, .75, 1, 1, 1, 1.5, 2, 2, 2, 3, 5, and 10 minutes. These interstimulus intervals are the same as those used by Mackworth (1950) and were randomized for each 30 minute period. Each target was set to appear for 6 seconds. The Weaponeer was set in the "kill" mode, so that the subject had immediate feedback as to whether or not he hit the target; that is, if he hit the target, it would fall; if he missed the target, it would remain in view until the six seconds of exposure time had elapsed (then it would fall). Target detection time was measured in terms of the time required by the subject to press the telegraph key in response to the presentation of the target. This time interval was measured by a Gerbrands Model G1280 electronic stop clock started through a relay in common with the target presentation switch of the Weaponeer control console. Pressing of the telegraph key de-activated the stop clock. Marksmanship was measured in terms of number of targets hit. Target detection and rifle marksmanship were averaged every 30 minutes. Mood was measured at the end of the test session when the subject was administered the Profile of Mood States (POMS) rating scale.

Target detection time was analyzed by means of a 6 x 7 (time period x interstimulus interval) repeated measures analysis of variance. Marksmanship was analyzed by means of a one-way repeated measures analysis of variance. Release 2.1 of CSS (StatSoft, 1988) was used to perform the analyses.

RESULTS

A significant main effect due to time on sentry duty (time period) was found for target detection time ($F(5,35) = 2.659$, ($p<.05$). Multiple comparisons showed that target detection time deteriorated with time on sentry duty such that impairments were not evident within the first hour (mean detection time for first 30 minute period = 989 milliseconds; mean detection time for second 30 minute period = 1033 milliseconds; $p>.40$) but were clearly evident by 1.5 hours (mean detection time for third 30 minute period = 1135 milliseconds; $p<.03$) and persisted for the remainder of the 3-hour session. This main effect is illustrated in Figure 1. The effect of the length of the interstimulus interval on target detection time was not statistically significant ($F(6,42) = 1.123$, $p>.30$). The interaction between sentry duty time and interstimulus interval was also not significant ($F(30,210) = 0.937$, $p>.50$).

Unlike target detection time, marksmanship remained constant over time ($F(5,35) = 0.683$, $p>.60$); soldiers were just as accurate at hitting the targets at the end of the 3 hours of sentry duty as they were at the beginning (mean no. targets hit per 30-minute period = 9.6).

Profiles of POMS mood scores for both practice and test sessions are graphically presented in Figure 2. The soldier's predominant mood during baseline practice was one of vigor. This profile conforms to the "iceberg profile" as described by Morgan (Morgan, 1980a, 1980b; Morgan and Pollack, 1977) for physically fit individuals who are likely to be successful in competitive sports. The three hours of sentry duty, however, led to the elimination of the "iceberg profile", with the predominant mood during sentry duty, being one of fatigue.

DISCUSSION AND CONCLUSION

Vigilance performance, as measured by target detection time, was found to remain unaffected for the entire first hour of sentry duty. This is twice as long as that reported by Mackworth with his sonar task, and is likely due to the relatively longer time interval (6 seconds) used for target presentation in this study. After one hour of sentry duty, subjects became less vigilant and this was manifested both in increased time to detect pop-up targets and in subjective reports of fatigue. Rifle marksmanship remained unaffected. In the real world, the fact that rifle marksmanship is continuously maintained is of secondary importance; that is, if a soldier does not detect the enemy before the enemy shoots, marksmanship is irrelevant (unless, of course, the enemy misses).

The results of this study suggest that sentry duty performance may be optimized if it is limited to one hour or less.

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NOTES

1. The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

2. Human subjects participated in this study after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

3. We would like to express our thanks and appreciation to SSG Douglas T. Dauphinee for his assistance in the collection of the data, and to CPT John Croke for his medical support.

TARGET DETECTION TIME

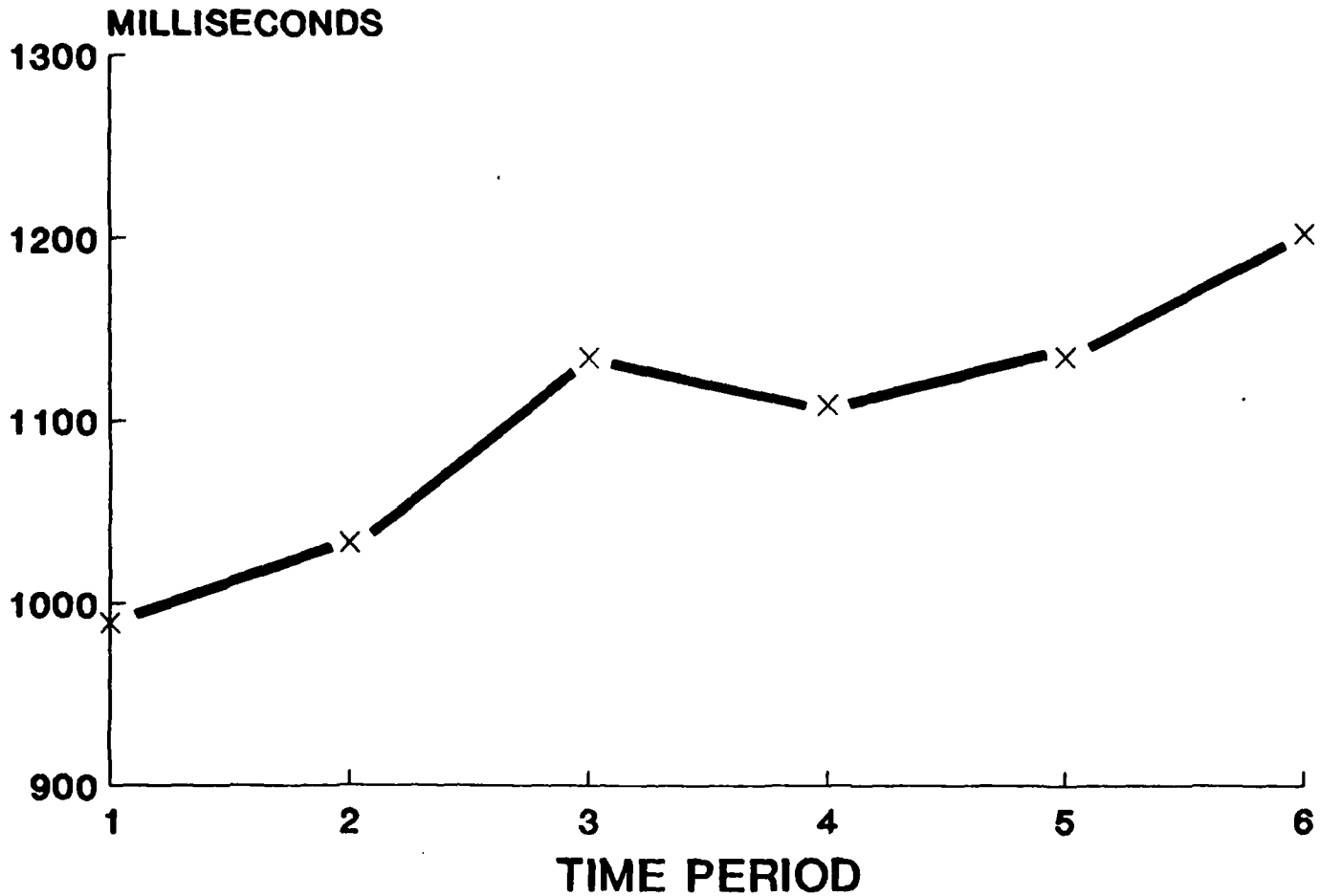

Figure 1.

MOOD RATINGS (POMS)

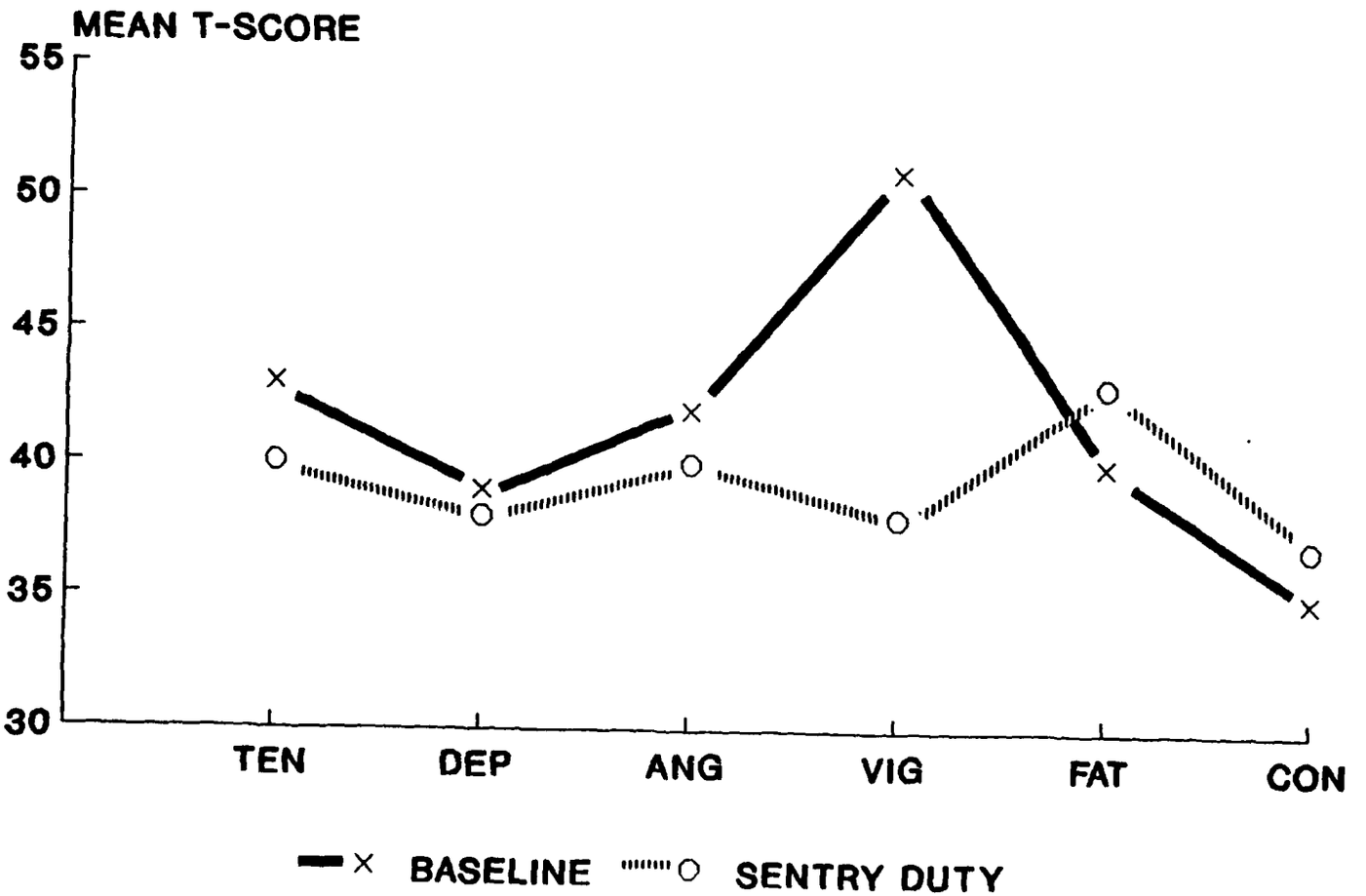

Figure 2.